





Arthrodesis of the Carpometacarpal Thumb Joint for Osteoarthritis; Long-Term Results Using Patient-Reported Outcome Measurements

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Abstract

Background Results following carpometacarpal (CMC) arthrodesis of the thumb for osteoarthritis vary widely in literature. Data on long-term patient-reported outcome measurements (PROMs) after thumb CMC joint arthrodesis for osteoarthritis are scarce.

Purpose We report the long-term outcomes of PROMs (function, pain, and satisfaction) after arthrodesis of the thumb CMC joint. We evaluated the correlation of function and pain with patient satisfaction.

Methods Long-term PROMs after thumb CMC arthrodesis for osteoarthritis were evaluated using a retrospective cohort (1996–2015). Three different PROM questionnaires (Disabilities of the Arm, Shoulder, and Hand Questionnaire, Dutch Language version [DASH-DLV], the Patient-Related Wrist and Hand Questionnaire Dutch Language version [PRWHE-DLV], and a questionnaire concerning satisfaction) were sent to all patients.

Results Twenty-five arthrodeses (21 patients) were available for long-term follow-up. The median follow-up time was 10.8 years (interquartile range [IQR]: 9.7–13.0). The median DASH score was 29.2 (IQR: 14.4–38.3), median PRWHE score was 25.0 (IQR: 12.5–44.3). The median satisfaction after the operation and satisfaction with outcome of the operation was 10 for both (on a Likert's scale with 1 worse and 10 excellent satisfaction). There was a statistically significant correlation between the PRWHE total score and PRWHE pain score and satisfaction with surgery and satisfaction with the result. There was no correlation between PRWHE function score and satisfaction or

Keywords

- ▶ arthrodesis
- ▶ carpometacarpal osteoarthritis
- ▶ basal thumb joint
- ▶ patient-reported outcome measurements

Osteoarthritis in the thumb carpometacarpal (CMC) joint is a common disease affecting 33% of postmenopausal women and causes pain, swelling, deformity, instability, loss of motion, and power. The thumb is involved in 40% of all hand function and the thumb CMC joint has been described as the most significant joint of the most important digit of the hand due to its

unique functional mobility.^{1–3} Besides the fact that the basal joint of the thumb is the second most involved hand joint (after the distal interphalangeal [DIP] joint) in osteoarthritis, it seriously impairs overall hand function and may require surgery when pain is not treated sufficiently with conservative therapy. Numerous procedures have been described for

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DASH and satisfaction. Results after hardware removal showed no significant differences compared with patients without hardware removal.

Conclusion Patients who underwent arthrodesis for thumb CMC osteoarthritis showed high satisfaction at long-term follow-up, despite moderate results as measured using the DASH and PRWHE. The PRWHE total and PRWHE pain scores correlated significantly with satisfaction with surgery and satisfaction with the result, respectively, whereas no correlation was observed with the PRWHE function score or DASH and satisfaction. This therapeutic study reflects level of evidence IV.

the treatment of advanced osteoarthritis of the thumb CMC joint. These include joint arthroplasty,^{4,5} CMC arthrodesis,^{6,7} and trapezial excision without⁸ or with ligament reconstruction and (soft) tissue interposition.^{9–11} Common goals for all these procedures are relieving pain and restoring thumb function but none of them has proven superiority above another after long-term follow-up.^{12,13}

Traditionally, arthrodesis is used for the treatment of post-traumatic patients or high-demand young patients with osteoarthritis because of the theoretically better stability and strength compared with the traditional trapeziectomy,^{14,15} accepting loss of motion of the thumb CMC joint. Previous research has found varying results.^{7,16–18} Arthrodesis gives a powerful thumb, but a common problem is nonunion, resulting in pseudoarthrosis. This, in combination with possible necessity of hardware removal, is the cause for many reoperations. In most of these studies, only traditional, physician-assessed outcome parameters were used, such as grip strength and range of motion. Patient-reported outcome measurements (PROMs) are becoming increasingly important in measuring overall outcome after surgical procedures.

Long-term data on PROMs in patients who underwent thumb CMC joint arthrodesis are scarce. Therefore, we conducted a study to evaluate long-term PROMs in patients after thumb CMC joint arthrodesis for osteoarthritis. To further explore patient satisfaction, we correlated pain and function on the one hand and patient satisfaction on the other.

Methods

Patients

We retrospectively reviewed all patients who underwent arthrodesis of the thumb CMC joint between 1996 and 2014 and were operated by the senior author. Inclusion criteria were arthrodesis performed using a T-plate and screws for thumb CMC joint osteoarthritis and follow-up of at least 5 years. We identified 42 patients with 47 arthrodeses. In 41 thumbs (35 patients), the reason for surgery was purely osteoarthritis.

All patients had radiological evidence of osteoarthritis in the thumb CMC joint (stage two or three according to Eaton and Glickel¹⁹) and were disabled by pain or loss of thumb function, or both. Surgical intervention was indicated after a period of watchful waiting and failure of nonoperative management (splinting and hand therapy). The choice for thumb CMC arthrodesis was made in case patients had a wish for a stable and powerful thumb.

Surgical Technique

The arthrodesis was performed through a longitudinal dorsal approach. The articular cartilage and subchondral bone of the opposing surfaces of the trapezium and base of the thumb metacarpal were resected with an oscillating saw. The position of the arthrodesis was such that the distal phalanx of the thumb rests on the middle phalanx of the index finger in a fully clenched fist, as described by Leach and Bolton.¹⁵ A five-hole 2.0 mm T-plate (mini AO from Depuy-Synthes Companies, Zuchwil, Switzerland) was used for fixation. In case of insufficient bone-to-bone contact and stable compression by the plate, a cancellous bone graft from the iliac crest was harvested and used for a stable arthrodesis. Postoperative immobilization consisted of a forearm-based thumb spica splint for 4 weeks with thumb in abduction. After the splint removal, supervised rehabilitation was started.

Follow-up Evaluation

After approval of the scientific committee, we contacted patients between October 2015 and July 2016 by postal mail. All patients that met the inclusion criteria for analysis were sent a cover letter explaining the goal of our study and three PROM questionnaires: the Disabilities of Arm, Shoulder, and Hand Questionnaire, Dutch Language Version (DASH-DLV),²⁰ and Patient-Related Wrist and Hand Evaluation, Dutch Language Version (PRWHE-DLV),²¹ and a questionnaire with questions about satisfaction. Written informed consent was obtained in all patients.

Electronic patient charts were reviewed retrospectively to determine demographic data, previous treatments, operative details, concomitant procedures, postoperative course, and complications.

At 3-month follow-up, patients underwent X-rays to establish the level of consolidation. After this regular follow-up, no additional X-ray controls were performed, unless clinically indicated.

One of the goals of our study was to evaluate patient satisfaction after thumb CMC arthrodesis for CMC osteoarthritis. As we found no acceptable widely used Dutch language satisfaction questionnaire for evaluation after surgery, we developed a questionnaire for satisfaction measurement based on the questionnaires used by Frouzakis et al.²² The first two questions assessed expectation before surgery. Patients were asked the reason why they sought treatment based on eight items (improvement in function of thumb, improvement in appearance of thumb, improvement in power, improvement in

pain, improvement in daily activities, improvement in activities of leisure, return to work, or other)²³ and the chance of success before operation on a 10-point Likert's scale (1, no success at all and 10, excellent satisfaction). The following questions assessed satisfaction after surgery, satisfaction with the outcome of the operation, both on a 10-point Likert's scale (1, completely dissatisfied and 10, excellent satisfaction), and whether the reason for treatment was achieved (on a 10-point Likert's scale; 1, not satisfied at all and 10, excellent satisfaction). The last questions focused on patient recommendation to family and friend and whether they would undergo the surgery again.

Statistical Analysis

Baseline characteristics and outcome measurements are presented for all patients individually. We used the Kolmogorov-Smirnov test and histograms to assess the distribution of the variables. We used median scores with interquartile range (IQR) because of nonnormally distributed data and absolute values and proportions (%) to present outcome for the total group of patients. Differences between the group with and without plate removal are analyzed with the independent samples Mann-Whitney *U*-test. Correlations between DASH/PRWHE and satisfaction were calculated using Spearman's rank correlation test for nonparametric data.

Results

Thirty patients with 35 arthrodeses were finally available for analysis. Nine patients (10 thumbs) declined participation. Twenty-one patients with 25 thumbs (four bilateral operated)

were available for follow-up evaluation (►Fig. 1). Demographics and baseline characteristics are shown in ►Table 1.

The scores for the DASH and PRWHE are presented in ►Table 2. Preoperative DASH scores were available for 12 patients, but because of the small number of patients, these scores were not used for analysis.

All satisfaction scores are given in ►Table 3. Pain was the main reason for operation in all cases. Besides pain, improvement of function and improvement of strength were in almost 50% of the cases accompanying reasons patients are seeking treatment for. Questions about satisfaction showed that patients estimated the chance of success before surgery as a 7, satisfaction with surgery as a 10, and satisfaction with the result also a 10 on a 10-point Likert's scale. Satisfaction with improvement after operation also scored 10 on the 10-point Likert's scale.

A total of 76% of the patients would recommend the operation to family or friends and although most patients scored high satisfaction, only 64% would undergo the operation again themselves. Two patients were not satisfied at all with the result of the operation. In these two patients, pain was the main reason for operation, and this was not sufficiently solved. They scored 1 and 2 for satisfaction with the result and 2 for satisfaction with improvement.

A significant negative correlation was seen between the PRWHE total and PRWHE pain scores and satisfaction with surgery. Thereby, a significant negative correlation between the PRWHE total score and PRWHE pain score and satisfaction with the result was seen. This negative correlation was not seen between the PRWHE function score and satisfaction with the result. Also for the DASH score, there was no correlation with satisfaction (►Table 4).

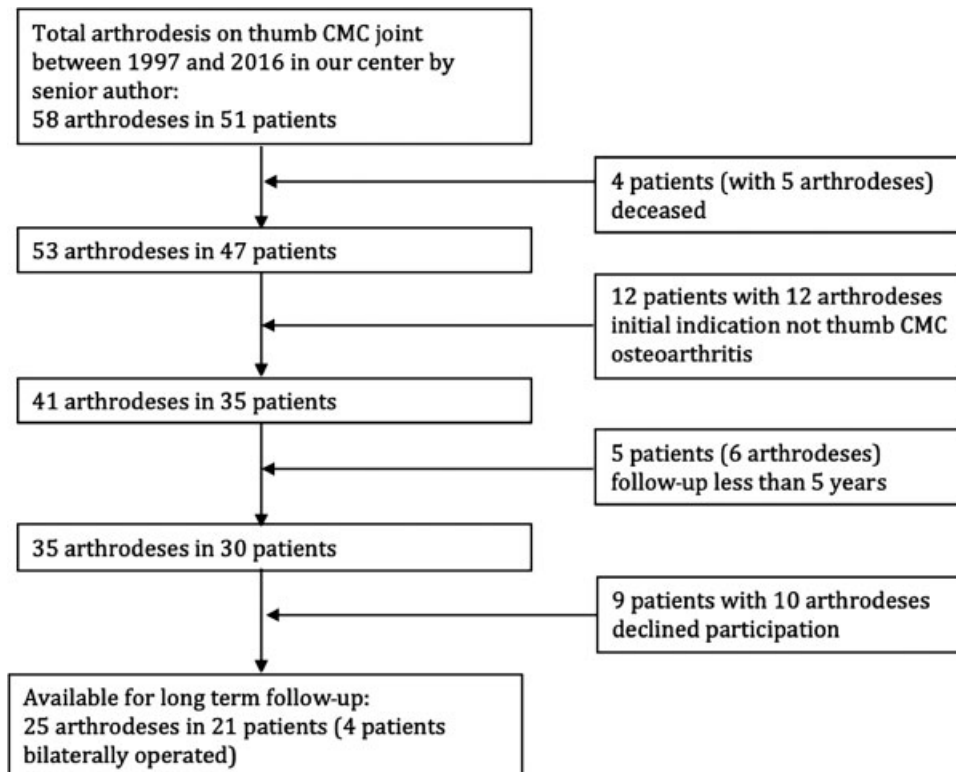


Fig. 1 Flowchart of patients.

Table 1 Demographics and baseline characteristics

	No. of patients (n)	%
Patients	21	
Thumbs	25	100
Single-side operated patients	17	
Bilateral operated patients	4	
Sex		
Male	11	44
Female	14	56
Age at treatment ^a		
Y (median)	53.0	
IQR	(48–61)	
Follow-up ^a		
Years (median)	10.8	
IQR	(9.7–13.0)	
Operated hand		
Left	11	44
Right	14	56
Dominant hand operated		
Yes	14	56
No	11	44
Heavy manual laboring job/leisure activities		
Yes	15	
No	–	
Unknown	10	
Complaints before operation		
< 1 y	3	12
1–2 y	5	20
2–5 y	7	28
> 5 y	9	36
Unknown	1	4
Technique		
T-plate	15	60
T-plate with cancellous bone	10	40
Complications		
None	21	84
Pseudo arthritis	1	4
Persisting pain STT	1	4
Pain after trauma	1	4
Pain MCP1	1	4
Secondary operations		
None	14	56
Removal implant material	8	32
Redo with cancellous bone	1	4
MCP1 arthrodesis	3	12
Proximal row carpectomy	1	4
Excision exophyte	2	8

Abbreviations: IQR, interquartile range; MCP1, first metacarpal phalangeal joint; STT, scaphotrapezotrapezoidal joint.

^aMedians and IQR are given because of nonnormal distribution of data.

Table 2 Scores for DASH and PRWHE

Arthrodesis patients		
	Median	Interquartile range
DASH ^a		
Total preoperative (n = 12)	52.1	35.4–58.8
Total final follow-up (n = 25)	29.2	14.4–38.3
PRWHE ^b (n = 25)		
Total score	25.0	12.5–44.3
Pain score	16.0	0.0–29.0
Function score	10.0	6.0–20.5

Abbreviations: DASH, disabilities of the arm, shoulder, and hand; PRWHE, patient-related wrist and hand questionnaire.

^aDASH: ranges from 0 to 100, with 0 and 100 indicating best and worst outcomes, respectively.

^bPRWHE: ranges from 0 to 50 for pain and function; with 0 best and 50 indicating worst outcome. Total score ranges from 0 to 100, with 0 best and 100 indicating worst outcome.

Table 3 Satisfaction

	Patients	%
Main reason for operation; improvement of ^a		
Pain	25	100
Function	12	48
Strength	12	48
Appearance	3	12
Perform daily chores	9	36
Perform activities of leisure	9	36
Return to work	5	20
Other reason	–	–
Advice to family and friends		
Yes	19	76
No	1	4
Not sure	5	20
Undergo operation again		
Yes	16	64
No	3	12
Not sure	6	24
	Median score	IQR
Success before surgery ^b	7.0	6.5–9.5
Satisfaction after surgery ^b	10	7.0–10.0
Satisfaction with result ^b	10	6.0–10.0
Satisfaction with improvement ^b	10	6.0–10.0

Abbreviation: IQR, interquartile range.

^aPatients were able to fill in more possibilities.

^bLikert's scale: 1 to 10, with "1" being not satisfied at all and "10" being excellent satisfaction.

Table 4 Correlation between DASH/PRWHE and satisfaction^a

	Satisfaction after surgery (CC/p-value)	Satisfaction with result (CC/p-value)
DASH final	-0.35/ <i>p</i> = 0.104	-0.29/ <i>p</i> = 0.168
PRWHE total	-0.58/ <i>p</i> = 0.004	-0.53/ <i>p</i> = 0.007
PRWHE function	-0.32/ <i>p</i> = 0.136	-0.20/ <i>p</i> = 0.34
PRWHE pain	-0.67/ <i>p</i> = 0.000	-0.70/ <i>p</i> = 0.000

Abbreviations: CC, correlation coefficient; DASH, disabilities of the arm, shoulder, and hand; PRWHE, patient-related wrist and hand questionnaire.
^aMeasured by Spearman's rank correlation.

Eight patients (32%) experienced implant-related irritation, which led to implant removal. In one patient, a trauma to the thumb initiated the implant-related irritation. Pain due to the implant irritation was solved by implant removal. We analyzed differences between patients based on removal of implant material. No significant differences were seen in demographics (► **Table 5**). There were also no significant differences between the outcomes of the group with the implant material still in place and the group after implant removal regarding pain, function, or satisfaction (► **Table 6**). Regarding the questions for satisfaction, three of the eight patients scored excellent satisfaction (scaled 10) after plate removal. For the other five patients, satisfaction was moderate to good (scaled from 5–8). For improvement of the initial reason for surgery, four patients scored moderate-to-good satisfaction (6–8) and four patients scored excellent satisfaction (10).

One patient experienced persistent pain within a year after operation and was diagnosed with nonunion based on X-rays. In this patient, a redo arthrodesis was performed with cancellous bone from the iliac crest, after which the pain was relieved. Two patients experienced pain which was related to an osteophyte around the thumb CMC joint. In the first patient, this osteophyte gave complaints after arthrodesis with cancellous bone and, thereafter, plate removal. Removal of the osteophyte resolved the pain. In the second patient, the osteophyte was seen after arthrodesis without cancellous bone. In this patient, only the osteophyte was removed (the implant material was left in place) with good outcome. There were no tendon injuries or nerve injuries related to the operation of the arthrodesis or related to the implant material seen.

Discussion

The main goal of surgical treatment of osteoarthritis in the thumb CMC joint is pain relief. The secondary goal is improvement or preservation of function, in terms of adequate stability and strength of the thumb.^{7,24} Both pain and function are measurable with PROM questionnaires. In most studies physician-reported measurements are used as outcome after thumb CMC joint surgery, but we were interested in the long-term results (minimum 5 years of follow-up) of PROMs to evaluate pain, function, and satisfaction.

With three different questionnaires, we evaluated different aspects of patient-reported outcomes, with special at-

Table 5 Comparison demographics with variable implant removal

Demographics	Implant removal	No patients
	No implant removal	17
	After implant removal	8
Sex		
Woman	No implant removal	11
Man		6
Woman	After implant removal	3
Man		5
Manual laboring yes	No implant removal	10
	After implant removal	5
Used technique		
Plate and screws	No implant removal	11
Plate, screws, and bone graft		6
Plate and screws	After implant removal	4
Plate, screws, and bone graft		4
Dominant hand operated		
No	No implant removal	7
Yes		10
No	After implant removal	4
Yes		4
		Median (IQR)
Age at initial treatment	No implant removal	53.0 (48.0–59.0)
	After implant removal	55.0 (49.0–66.5)
Follow-up in years after initial treatment	No implant removal	10.8 (9.6–12.5)
	After implant removal	11.4 (9.9–14.2)
Months from initial surgery to implant removal	No implant removal	–
	After implant removal	26.0 (12.0–41.0)

Abbreviation: IQR, interquartile range.

tention to satisfaction. This gives a good patient perspective on the outcome of surgery.

Results in terms of function and pain measured by the DASH questionnaire were comparable to previous studies describing arthrodesis of the thumb CMC joint.^{17,25} One other study reviewed the DASH and PRWHE questionnaire on the long term. The outcomes of this study¹⁶ on the DASH and PRWHE were worse than our outcomes. Their study was terminated prematurely, because of complications in the arthrodesis group. We did not observe such a high-complication ratio in our study, which can explain the difference in scores.

Comprehensive satisfaction questions are not described in literature before for arthrodesis of the thumb CMC joint. We observed high satisfaction with the outcome of surgery and with the surgery itself. Satisfaction is expected to be high when

Table 6 Comparison of PROMs with variable implant removal

PROMs		Median (IQR) ^a	p-Value ^b
DASH	No implant removal	37.5 (22.9–39.4)	0.124
	After implant removal	18.2 (9.0–28.8)	
PRWHE pain	No implant removal	15.0 (0.0–27.5)	0.842
	After implant removal	22.0 (2.0–36.3)	
PRWHE function	No implant removal	14.5 (5.5–23.8)	0.440
	After implant removal	8.0 (5.8–19.1)	
PRWHE total	No implant removal	25.0 (14.3–43.3)	0.374
	After implant removal	31.3 (7.9–22.7)	
Satisfaction with result	No implant removal	10.0 (6.0–10.0)	0.511
	After implant removal	7.0 (6.0–10.0)	
Satisfaction with surgery	No implant removal	10.0 (8.0–10.0)	0.213
	After implant removal	7.5 (5.5–10.0)	
Satisfaction with improvement	No implant removal	10.0 (7.0–10.0)	0.669
	After implant removal	9.0 (6.0–10.0)	

Abbreviations: DASH, disabilities of the arm, shoulder, and hand; IQR, interquartile range; PROMs, patient-reported outcome measurements; PRWHE, patient-related wrist and hand questionnaire.

^aMedian and IQRs are given because of nonnormal distributed data.

^bIndependent sample Mann–Whitney *U*-test.

the expectation of a patient before surgery is fulfilled.²² In the present study, the reason patients seeking operative treatment was pain in all cases (► **Table 3**). Improvement of function or improvement of strength was, in less than half of the patients, the reason patients wanted operative treatment. We found that pain after surgery is highly correlated with satisfaction after surgery, but there was less clear correlation with satisfaction and function as measured by either PRWHE or DASH. This implies that pain is an important factor of influence on outcome in terms of satisfaction. This can be explained by the result that pain is the most important factor for patients to seek operative treatment. When pain is decreased satisfactory after surgery, high satisfaction can be expected. This influence on satisfaction is higher than improvement of function or strength, even in this group of patients with a demand for a powerful thumb preoperatively.

The patient's perspective and, more specifically, patient satisfaction is important because it helps to determine whether an operation has been a success. Function and pain are measured in most questionnaires, but questions about satisfaction and expectations before and after surgery are not regularly incorporated in most pre- and postoperative follow-up for hand surgery questionnaires. Frouzakakis et al²² recently described that fulfilling expectations after surgery is an important factor influencing satisfaction after surgery. Until recently, objective outcome measurements were mostly used to present results after arthrodesis for CMC thumb osteoarthritis, with varying results.

In 2009, Rizzo et al⁷ published a retrospective review with an average follow-up of 11.2 year (range: 3–28 years) after thumb CMC joint arthrodesis with different techniques. A total of 126 patients were available for follow-up with good results in terms of pinch, power of grip, and visual analogue

scale (VAS) pain scores. No PROMs were used. Seventeen nonunion patients and 39 cases of scaphotrapezotrapezoidal (STT) arthritis were described, but surgical treatment was clinically necessary in a relatively small number of patients. Nine of the nonunions needed reoperation and eight patients of the STT arthritis were asymptomatic. The authors concluded that there is still a role of arthrodesis of the thumb CMC joint.

A published randomized controlled trial (RCT) comparing ligament reconstruction and tendon interposition (LRTI) with arthrodesis²⁶ showed a high-complication rate after arthrodesis (20% pseudoarthrosis), which led to premature closure of the trial. A total of 43 patients were included in the trial, with 17 patients in the arthrodesis arm. Based on these results, they concluded that arthrodesis should not routinely be performed as treatment for thumb CMC osteoarthritis. Recently the 5-year follow-up results were also published¹⁶ which showed comparable results with their short-term report. Compared with the present study, their results in terms of DASH and PRWHE were slightly worse. As only women over 40 years of age were included in the RCT, results might be less comparable to those of the present study.

We believe that independent of the presence of complications, patient-reported outcome and, especially, satisfaction should play an important role in determining the optimal treatment option. The more enhanced satisfaction questionnaire, which was used in the present study, provides important additional information on that subject.

Previous studies^{12,13,18,24,27} showed that arthrodesis of the thumb CMC joint was associated with more reoperations and complications compared with other techniques such as LRTI or trapeziectomy alone. In our study, eight patients required implant removal, all with acceptable results after implant

removal. Although the results of patients without reoperation were better than in the group after implant removal, no significant differences in outcome between the groups were seen (► **Tables 5** and **6**). This implies that implant removal can be performed after arthrodesis, without extensive consequences. One important complication previously described after arthrodesis was nonunion.¹⁸ In contrast to the reported 20% nonunion, only one patient developed a nonunion (4%) in the present study. This patient required a second operation because of persisting pain. For arthrodesis, a stable fixation is important in preventing nonunion. Stable fixation is achieved by a firm fixation method, such as with T-plate and screws, and the use of cancellous bone when there is not sufficient bone-to-bone contact, as done in the present study.

However, Smeraglia et al¹⁷ concluded that the objective, as well as subjective, outcome measurements did not correlate with bone union and that failure to gain bone union did not affect outcome. This supports the importance of PROMs instead of using only complications or physician-reported outcome measurements to determine optimal-treatment options.

Satisfaction can be viewed from the perspective of process-related satisfaction versus outcome of treatment-related satisfaction.²⁸ The emphasis of the present study was on the outcome of treatment because of the retrospective design of the study. After an average follow-up of 10 years, it seemed logical not to focus on the process of care.

Limitations

This study obviously had its limitations. The first is its retrospective nature which might have led to selection bias. Second, we did not perform objective measurements such as range of motion and power of grip. Finally, we did not have the opportunity to perform sequential measurements to observe outcome changes in time.

Conclusion

In conclusion, we saw good-to-moderate outcomes on long-term PROMs with the PRWHE, DASH, and a questionnaire concerning satisfaction.

There was a significant correlation between pain and satisfaction with the result of surgery but not between function and satisfaction with the result of surgery. This finding further supports the need to discuss treatment goals with patients before surgery for thumb CMC osteoarthritis. Future research should, therefore, focus on prospective long-term results with focus on PROMs to determine the optimal treatment for thumb CMC osteoarthritis.

Note

The research was performed with patients of the Division of Plastic and Hand Surgery, University Medical Center Utrecht, Utrecht, the Netherlands. Approval of the local scientific committee of the University Medical Center Utrecht was obtained.

Conflict of Interest

None declared.

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